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# Acute Appendicitis Following Blunt Abdominal Trauma

## *Incidence or Coincidence?*

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Inflammation of the appendix is a common cause of acute abdominal pain. The etiology and pathophysiology of appendicitis have been well described. The initiating factor often is obstruction of the appendiceal lumen by inspissated stool, barium, food, parasites, or hyperplastic lymphoid tissue. Two patients have been identified who developed appendicitis temporally related to blunt abdominal trauma, without other clear etiology. Although absolute documentation of trauma as an etiologic factor in these cases is difficult, theoretical mechanisms for the occurrence are discussed. In the setting of right lower quadrant pain following mild to moderate blunt abdominal trauma, acute appendicitis should be considered as a possibility.

**A**CUTE APPENDICITIS IS the most common acute surgical condition of the abdomen. Primary bacterial invasion of the appendiceal lymphoid tissue described by Aschoff<sup>1</sup> dominated theories as to the etiology of the disease until the late 1930s. This 'catarrhal appendicitis' was believed to be due to increased virulence of enteric bacteria or to regional enteritis. The concept of obstruction as the cause had been described as early as 1896 in separate work by Dieulafoy<sup>2</sup> and Talamon<sup>3</sup>; however it was not until the classic work of Wangenstein<sup>4</sup> in 1937 that obstruction was established as the principal cause of acute appendicitis. He and his colleagues<sup>5-7</sup> reproduced the disease in rabbits, apes, and humans by ligation of the appendix. Inflammation occurred despite eradication of resident flora by irrigation. Recently Pieper<sup>8</sup> duplicated these results in rabbits and showed that the length and degree of obstruction correlate with the severity of the disease. Various mechanisms of obstruction have

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been reported. Trauma as a cause of obstruction resulting in appendicitis has only been alluded to anecdotally.<sup>9-12</sup> We present two cases of appendicitis in patients who presented to the emergency department with abdominal pain following mild to moderate blunt trauma to the lower abdomen.

### Case 1

A 46-year-old auto mechanic presented to the emergency department complaining of abdominal pain. He related the onset of pain to an incident that occurred 2 days earlier: a V8 engine transmission weighing at least 200 pounds fell on his lower abdomen and pelvis. The initial pain was 'soreness and stiffness,' which resolved. Then he experienced a 'dull aching all the way across' the lower abdomen, radiating into the back and groin. He also complained of hesitancy, straining to void, and difficulty 'catching my breath.' He was able to eat in small amounts but his appetite had been poor. He was nauseated, but had not vomited and had a normal bowel movement the night before admission. He denied fever, chills, or other symptoms of pain before the accident.

Physical examination revealed that he was in mild respiratory distress, with temperature of 38.6 C, pulse of 88, respirations of 30, and blood pressure of 150/100. Examination was unremarkable except for the abdomen, which was distended with some low-pitched bowel sounds. No tenderness on movement or no peritoneal irritation were noted. There was bilateral lower quadrant pain to palpation that was worse on the right and referred to the suprapubic region. No hernias or masses were palpated. Rectal tone was normal, with a firm prostate and soft, hematest-negative stool. Urinalysis revealed ketones, moderate white blood cells without bacteria, and a small number of red blood cells. Complete blood count revealed a leukocytosis of 12,900 with a left shift and hemoglobin of 14. Plain films were unremarkable. A cystogram revealed no evidence of extravasation. A computed tomographic scan showed a 'small amount of fluid (? blood) in the region of the cecum and mesentery' without retroperitoneal injury.

The patient was admitted for observation. Following admission he remained febrile but hemodynamically stable. He became more distended, his pain increased, and his white blood cell count increased to 16,900. Midline celiotomy was performed and a gangrenous appendix

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\* Deceased.

Reprints will not be available.

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was found. On closer exam, marked edema of the cecum was noted, with several small areas of subserosal hemorrhage. Appendectomy was performed and no fecalith was identified. The patient did well after operation and was discharged 3 days later. The possibility of transection and/or thrombosis of the small blood vessels was entertained.

#### Case 2

The second patient was a 12-year-old boy who was brought to the emergency department approximately 12 hours after falling off his bicycle. During the accident he had been struck in the lower abdomen by the handle bars of the bicycle. He had no loss of consciousness and the handle bar injury seemed superficial. Eight hours after the accident the child began to experience vague abdominal discomfort followed by mild nausea and anorexia. In the next 4 hours the pain intensified and the child was first brought to the emergency room for evaluation.

On presentation he appeared ill with a temperature of 38.2 C and blood pressure of 110/60. He complained of abdominal pain. Examination revealed several superficial abrasions, but no other sequelae from the accident were visible. The abdomen was quiet, nondistended, and there was diffuse lower quadrant tenderness. On deep palpation no mass was appreciated; however voluntary and involuntary guarding were elicited on deep palpation of the right lower quadrant. Rectal examination was normal. Laboratory results were remarkable for a hematocrit of 43%, a white blood cell count of 13,000, a normal urinalysis, and a normal serum amylase. The child was admitted for observation. During the next 4 hours he continued to be febrile with continued right lower quadrant pain. He was taken to the operating room and found to have acute suppurative appendicitis. Appendectomy was performed and the child was discharged on the second postoperative day.

#### Discussion

Approximately 7% of individuals in the western hemisphere develop appendicitis during their lifetime. The peak incidence is during the second and third decades of life. Two hundred thousand appendectomies for acute appendicitis are performed each year in the United States. In Africa and Asia there is a lower incidence, which has been attributed to the high-residue diet consumed in these areas.<sup>13</sup>

The natural history of acute appendicitis is inflammation leading to perforation in less than 36 hours. In 60% to 70% of acutely inflamed appendices, obstruction of the proximal lumen by fecaliths, fibrous bands, parasites, or tumors can be demonstrated. The specimen should be examined closely at the time of operation. Hyperplastic lymphoid tissue resulting from viral illness also has been shown to cause obstruction. Lymphoid hyperplasia may be the most common cause of luminal compromise.<sup>14</sup> Regardless of the cause of luminal obstruction, the subsequent series of events leading to appendiceal inflammation is the same.

Van Zwalenburg<sup>15</sup> in 1904 suggested that obstruction leads to distention of the appendiceal lumen as a result of mucosal secretion. The distention increases with continued mucosal secretion and the rapid multiplication of resident bacteria. Anaerobes and other gram-negative organisms produce a variety of proteolytic enzymes. A closed

loop is created similar to the intestinal closed loop first described by Whipple<sup>16</sup> in 1912. As pressure in the submucosa increases, venous pressure is exceeded and capillary and venous occlusion result. Arterial inflow continues and causes progressive vascular engorgement and congestion. The appendiceal mucosa is compromised by impairment of its vascular supply allowing proteolysis and bacterial invasion of the wall. This usually occurs in the mid-appendiceal antimesenteric border due to the tenuous endarteriolar status of this region. In the setting of continued ischemia, bacterially induced proteolysis leads to microinfarcts and subsequent perforation.

The association of acute appendicitis with blunt abdominal trauma is unclear. Some have considered an association to be coincidental. Because blunt abdominal trauma and acute appendicitis both occur with some frequency, and largely in the same population, this hypothesis is reasonable. Others have theorized that appendicitis may actually precede the traumatic events with vague symptoms compromising the patient so as to place him or her at greater risk for trauma. In other words, the physician should consider that, for instance, the child may have fallen off his bicycle due to abdominal pain in the first place. Furthermore it is probable that the patient, and therefore the physician, becomes focused on the traumatic event to the exclusion of early symptoms of appendicitis.

Whether blunt abdominal trauma can be the inciting event leading to obstruction and subsequent acute inflammation is difficult to substantiate. It is feasible, however, that trauma could set into motion the same vicious cycle proposed by Van Zwalenburg. Wells<sup>17</sup> found no development of appendicitis in five rabbits following direct crush injury to the mucosa in the absence of obstruction. Dennis<sup>18</sup> found the opposite result in two rabbits. Direct trauma might lead to edema formation, hematoma, and/or hyperplasia of intrinsic lymphoid tissue with subsequent obstruction of the lumen. Indirectly ileocecal hematomas, mesenteric disruption, edema with enlarged mesenteric nodes, or displacement of stool could easily obstruct the lumen. Features contributing to the obstruction and subsequent development of the disease would include the position of the appendix, mesentery and contained stool at the moment of injury, the actual mechanism of injury, the anatomy of the appendix, mesoappendix, and vascular supply, the resident bacterial flora, and the host immune response.

Although a causative relationship between trauma and appendicitis cannot be proved in the two cases presented, the temporal relationship certainly raises questions of causality. Clearly appendicitis can be a difficult diagnosis to make in a hospitalized patient, and trauma is no exception to this aphorism. Because appendicitis and blunt trauma are both common entities, their coexistence (even

if coincidental) is certainly feasible. Based on our experience with these two cases, we suggest that appendicitis be considered in the patient with right lower quadrant pain and tenderness following blunt trauma.

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